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OFFICE OF
PREVENTION PESTICIDES AND
TOXIC SUBSTANCES

**Memorandum**

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**SUBJECT:** Initial Biological and Economic Analysis of Azinphos-methyl and Phosmet on Pears

**FROM:** Colwell A. Cook, Entomologist
Herbicide and Insecticide Branch

Timothy Kiely, Economist
Economic Analysis Branch
Biological and Economic Analysis Division (7503C)

**THROUGH:** David Brassard, Senior Entomologist
Jonathan Becker, Acting Chief
Herbicide and Insecticide Branch

Arthur Grube, Senior Economist
David Widawsky, Team Leader and Acting Chief
Economic Analysis Branch

**TO:** Diane Isbell, Chemical Review Manager
Veronique LaCapra, Chemical Review Manager
Margaret Rice, Chief
Reregistration Branch 2
Special Review and Reregistration Division (7508C)

**CC:** Denise Keehner, Director
Biological and Economic Analysis Division

**SUMMARY**

The impacts of extending the restricted entry intervals for azinphos-methyl and phosmet on pears would be significant in the Pacific Northwest Region (Washington and Oregon) and California, which together account for 98% of U.S. pear production. Both chemicals are critical for the control of codling moth, which is the primary pest on pears in both regions. Phosmet's critical use is late season due to its shorter PHI, and azinphos-methyl is critical for early and mid-season codling moth control.

Extending the phosmet REI on pears to longer than 7 days will not allow growers to use phosmet and still achieve adequate control of codling moth and begin hand harvesting activities. Growers will not use phosmet, and will have to use less effective alternatives for codling moth control, resulting in losses in yield and fruit quality. Grower net revenues could decline as much as 7 times current grower net revenues in the Pacific Northwest, and more than 2 times current grower net revenues in California. At the regional level, net revenues could decline as much as 2 times current regional net revenues in the Pacific Northwest, and nearly 50% from current regional net revenues in California. And at the national level, net revenues could decline as much as 100% from current national net revenues.

Extending the azinphos-methyl REI on pears to longer than 7 days for irrigation activities and 14 days for fire blight removal will not allow growers to use azinphos-methyl and still carry out critical irrigation and fire blight removal activities. Growers will not use azinphos-methyl, and will use more expensive alternative chemical controls for codling moth, resulting in higher costs. Grower net revenues could decline as much as 33% from current grower net revenues in the Pacific Northwest, and as much as 10% from current grower net revenues in California. At the regional level, net revenues could decline more than 25% from current regional net revenues in the Pacific Northwest, and as much as 5% from current regional net revenues in California. At the national level, net revenues could decline as much as 33% from current national net revenues.

If both the phosmet REI is extended beyond 7 days, and the azinphos-methyl REI is extended beyond 14 days for fire blight removal and 7 days for irrigation, growers will not use either azinphos-methyl or phosmet, and growers will face yield and quality losses, and higher chemical control costs. Grower net revenues could be reduced by as much as 12 times current grower net revenues in the Pacific Northwest, and 4 times current grower net revenues in California. At the regional level, net revenues could be reduced by as much as 9 times current regional net revenues in the Pacific Northwest, and 1 3/4 times current regional net revenues in California. At the national level, net revenues could be reduced by as much as 4 ½ times current national net revenues.

## BACKGROUND

Pears (*Pyrus communis*) are a pome fruit related to apples. Bartlett is the most common variety grown in the U.S. Most of the production of Bartlett pears goes for canning, although early in the season, some will go for fresh market. D'Anjou, the next most common variety grown in the U.S., is grown primarily for fresh market.

### Pear Cultural Practices

The life cycle of a pear tree is similar to other fruit trees, such as apples. In general, the trees will break their dormant/delayed dormant phase in early to mid-April. Pink through petal fall stages occur from mid-April through mid-May. The fruit may mature as early as late July or as late as October depending upon variety.

Orchard activities include: pruning, propping/tying, irrigation, scouting, hand thinning and hand harvesting. Pruning is done when the trees are dormant. Scouting occurs on a weekly basis throughout the growing season. Irrigation is necessary throughout the growing season as water management is critical. There is little to no hand thinning in pears. In Washington and Oregon, d'Anjou pears are hand thinned, but these pears are not as susceptible to the primary insect pest on pears (codling moth) and subsequently are not often treated with phosmet nor azinphos-methyl. Propping/tying will be performed in late spring to summer. The timing of hand harvesting depends upon the variety and can occur from August through October.

### U.S. and Regional Pear Production

Total U.S. pear production averages 991,000 tons per year, and is valued at nearly $290 million (see Table 1). California and the Pacific Northwest (Oregon and Washington) account for 98% of U.S. pear production. The major production region is the Pacific Northwest, and the major production state is Washington.

Table 1. Average Pear Production and Value of Production in the U.S., California, and the Pacific Northwest Region (Oregon, Washington)[1, 2]

| Region | Bearing Acreage (Acres) | Production (1000 Tons) | Percent of U.S. Production | Value of Production ($1000) |
|---|---|---|---|---|
| U.S. | 66,200 | 991 | – | $289,810 |
| California | 19,300 | 324 | 33% | $77,364 |
| Pacific North | 42,200 | 643 | 65% | $203,249 |
| Oregon | 17,800 | 235 | 24% | $88,704 |
| Washington | 24,400 | 408 | 41% | $114,545 |

1. Production of pears in Michigan, New York, Pennsylvania accounts for 2% of U.S. production; production in Colorado, Connecticut, and Utah accounts for <1% of production.
2. Source: USDA/NASS Non-citrus Fruits and Nuts 2000 Preliminary Summary.

Table 2 lists U.S. pear production and the value of production by end use market. This data is not available for all pear types by region or state. Nearly 60% of production is fresh, while 40% is for the processed market.

Table 2. Pear Production and the Value of Production in the U.S. by End Use Market for the Year 2000 [1, 2, 3]

| Production (1000 tons) | | | Value of Production ($1000) | | |
|---|---|---|---|---|---|
| Total | Fresh | Processed | Total | Fresh | Processed |
| 957,200 | 564,750 | 392,450 | $255,354 | $183,239 | $72,115 |

1. Source: USDA/NASS Non-citrus Fruits and Nuts 2000 Preliminary Summary.
2. 98% of U.S. pear production occurs in California, Oregon, and Washington. Production of pears also occurs in Michigan, New York, Pennsylvania, Colorado, Connecticut, and Utah (less than 3% of U.S. production).
3. Production by end use market not available for all pears by region or state.

## USE OF AZINPHOS-METHYL AND PHOSMET ON PEARS

### Target Insect Pests

The primary insect pest for which phosmet and azinphos-methyl are applied to pears is the codling moth, *Cydia pomonella*. A secondary insect pest for which phosmet is applied to pears is the grape mealybug, *Pseudococcus maritimus.*

Codling moths overwinter as fully grown larvae, hibernating in silken cocoons in places of concealment on or near fruit trees or packing sheds. Pupation takes place in the spring, and moths emerge about the time fruit trees are in bloom. A female moth may deposit about 300 eggs during her 2-3 week life-span. The timing of egg hatch depends on temperature and may range from 5 days to 2 weeks. Larvae tunnel into the fruit, feed for about 3 weeks, then leave and pupate in or near the tree. Pupation usually takes about 2 weeks. Overlapping generations are not uncommon. It is the larval stage that causes injury to the fruit. They tunnel into the fruit, where their feeding and excrement causes rot. This lowers the commercial value and storage quality of the pear.

Some locations of the Pacific Northwest had been reporting resistance to phosmet and azinphos-methyl in the codling moth populations. In some areas, it was the adult moth that was resistant to phosmet and azinphos-methyl; in other cases, it

was the larvae. And in some areas both stages demonstrated resistance. However, both adult moths and larvae are still killed with the full rate of phosmet or azinphos-methyl.

A secondary insect pest targeted by azinphos-methyl and phosmet in pears is the grape mealybug. The grape mealybug overwinters as crawlers in egg sacs beneath bark scales and in cracks. Crawlers emerge from pink to petal fall. Crawlers are covered with a wax coating, which thickens they get older. Once settled, the crawlers start to feed and become progressively harder to kill. Typical of mealybugs, this insect sucks plant sap and excretes honeydew, which then serves as a medium for sooty fungus. Outbreaks of grape mealybugs occur during the pre-bloom stage of the pears, consequently this is the time that chemical control measures, usually chlorpyrifos, are applied.

**Phosmet and Azinphos-methyl Usage**

More than half of the phosmet usage on pears in California and the Pacific Northwest is for the control of codling moth, while grape mealybug control accounts for less than 5% of the phosmet pear usage. Table 3 presents U.S., regional, and state usage of phosmet on pears.

Table 3. Usage and Per Acre Costs of Phosmet on Pears by Region and Major State [1]

| Region/ State | Percent of Crop Treated | Base Acres Treated (1000 acres) [2] | Total Pounds Applied (1000 lbs) | Average Number of Applications (#/year) [3] | Average Application Rate (lbs/acre) [3] |
|---|---|---|---|---|---|
| U.S. | 26% | 17 | 76 | 1.7 | 2.49 |
| California | 19% | 4 | 20 | 1.8 | 2.79 |
| Pacific North | 29% | 12 | 53 | | |
| Oregon | 47% | 8 | 37 | 1.6 | 2.67 |
| Washington | 16% | 4 | 16 | 1.6 | 2.66 |

1. Source: USDA/NASS Fruit and Nut Chemical Use, 1997 and 1999.
2. Base acres treated calculated using percent of crop treated estimates and bearing acreage from Table 1.
3. Application rates and the number of applications are not available for the Pacific North region.

Nearly two thirds of azinphos-methyl usage on pears in California and the Pacific Northwest is for the control of codling moth, while grape mealybug control accounts for less than 5% of the azinphos-methyl pear usage. Table 4 presents regional usage and average application rates of phosmet on pears.

Table 4. Usage of Azinphos-methyl on Pears by Region and Major State [1]

| Region/ State | Percent of Crop Treated | Base Acres Treated (1000 acres) [2] | Total Pounds Applied (1000 lbs) | Average Number of Applications (#/year) [3] | Average Application Rate (lbs/acre) [3] |
|---|---|---|---|---|---|
| U.S. | 66% | 44 | 103 | 2.3 | 1.00 |
| California | 47% | 9 | 35 | 2.8 | 1.09 |
| Pacific North | 74% | 31 | 64 | | |
| Oregon | 70% | 12 | 23 | 1.9 | 1.00 |
| Washington | 78% | 19 | 41 | 2.1 | 1.01 |

1. Source: USDA/NASS Fruit and Nut Chemical Use, 1997 and 1999.
2. Base acres treated calculated using percent of crop treated estimates and bearing acreage from Table 1.
3. Application rates and the number of applications are not available for the Pacific North region.

**Phosmet and Azinphos-methyl Use**

Applications of phosmet or azinphos-methyl to pears are timed to flights of the codling moth. Most pear growers (85-95%) participate in using a mating disruption scheme for codling moth. Flight traps are placed throughout the growing region and monitored. When codling moths are trapped the orchards are flooded with female codling moth pheromone, which confuses males. Scouting is intensified and when the first eggs of codling moth are found, consultants and growers can use degree-days to determine when the eggs will hatch. Phosmet or azinphos-methyl will be applied to coincide with that hatch. Unfortunately, mating disruption is not a stand alone program, and does usually require at least one application of insecticide. The California pear industry has reported a reduction of OPs for codling moth control when in conjunction with the mating disruption.

In areas that have high codling moth pressure the growers apply phosmet or azinphos-methyl at the maximum rate and up to 4 times a season. In areas of low codling moth pressure phosmet or azinphos-methyl is applied only once in the season at a rate of 3 lbs. of product. In many areas azinphos-methyl is the first choice for the early season flights since it is perceived to be more efficacious than phosmet. Due to the current longer REI to hand harvest for azinphos-methyl (14 days), only phosmet (at a 7-day pre-harvest interval) is available if a third flight of codling moth should occur close to harvest.

The pre-bloom outbreak of grape mealybug is usually controlled with an application of chlorpyrifos. Subsequent generations will be controlled by the azinphos-methyl or phosmet applications that are aimed at the codling moth.

**Alternative Control**

Since the mid-1990s use of the pheromone mating disruption system has reduced the use of the organophosphates and resistance to the organophosphates has apparently been decreasing. Unfortunately, mating disruption is not a stand alone system and works best when pest populations are low. There are no other registered chemicals that control the codling moth as well as azinphos-methyl and phosmet. Diazinon is rated as fair but has to be applied every week or ten days to provide some control of codling moth. In some areas of California this chemical is used where orchards border homes or public lands. If codling moth populations are low and growers use mating disruption, there is potential for a 20-25% yield reduction when diazinon is used.

Esfenvalerate, fenpropathrin, and permethrin are less efficacious than azinphos-methyl and phosmet. These pyrethroids have the added disadvantage of reducing predatory mite populations, resulting in a flare of pest mites. Growers can manage this problem only with the addition of at least 2 miticide applications, adding to environmental load and growers' costs. Pyrethroids also tend to cause outbreaks of pear psylla, so applications for the control of this pest may be required as well.

Studies with tebufenozide have demonstrated that it is not very efficacious against codling moth. Carbaryl has some activity on codling moth but it is very short-lived. Growers may apply carbaryl if they have codling moths hatching in the orchard and harvest is within 5 days.

Chlorpyrifos has demonstrated good control of the grape mealybug. However, studies of imidacloprid have shown only fair control of the grape mealybug as compared to azinphos-methyl and phosmet.

**RESTRICTED ENTRY INTERVALS (REIs)**

**Phosmet:** The current label REI is 1 day, and the PHI is 7 days. Please refer to the occupational and residential human health risk assessment on the Agency's website (http://www.epa.gov/pesticides/op) for information concerning the worker risks associated with the restricted entry intervals for this chemical. The phosmet registrant has proposed a 7 day restricted entry interval for all activities.

**Azinphos-methyl:** The current label REI is 14 days for hand thinning and hand harvesting, and 2 or 3 days for all other activities. Please refer to the occupational and residential human health risk assessment on the Agency's website (http://www.epa.gov/pesticides/op) for information concerning the worker risks associated with the restricted entry intervals for this chemical.

**IMPACTS RELATED TO OCCUPATIONAL RISK MITIGATION**

**Phosmet**

Phosmet's critical use on pears is for the control of codling moth late season, prior to hand harvesting. An REI of 7 days for phosmet should not significantly impact the production of pears. An REI of 7 days matches the existing pre-harvest interval**.** Pear growers have moved to phosmet for late season control of codling moth due to the extension in the PHI for azinphos-methyl to 14 days, and an REI longer than 7 days for phosmet would not allow growers to get adequate control of codling moth and begin hand harvesting activities.

An REI beyond 7 days for phosmet would likely result in pear growers discontinuing the use of phosmet late season and using other chemical controls (i.e., diazinon, pyrethroids) for late season codling moth control. The alternatives to phosmet are not as effective and could potentially lead to impacts on pear fruit yield and quality due to increased pest presence and pest damage. Estimates of losses in yield and quality from increased pest pressure range from 20-25%, with the potential of 100% loss from rejection if there is a perceived pest problem with a grower's crop. Secondary pest outbreaks could also result from alternative chemical control, resulting in potential yield and quality impacts as well. Resistance will also likely become a more widespread problem because growers will have to rely on fewer chemicals for insect control.

**Azinphos-methyl**

The REI of 14 days for hand harvesting for azinphos-methyl has essentially removed this chemical from use by pear growers in the later part of the growing season, because that overlaps with the possible last flight of codling moth. Azinphos-methyl use is critical for first and second generation codling moth control, which, at an REI beyond 7 days, will interfere with critical irrigation activities in spring and summer months. For the removal of fire blight through the culling of diseased branches, growers need to be back in the field no more than 14 days after azinphos-methyl applications. At a REI longer than 14 days, the application of azinphos-methyl for codling moth would interfere with fire blight removal activities. Fire blight is a disease, which if not controlled, could potentially lead to tree loss and, therefore, significant yield losses. Activities such as hand thinning, propping, and tying are not as critical for pear varieties susceptible to codling moth.

An REI longer than 7 days for irrigation and 14 days for fire blight removal for azinphos-methyl would likely result in pear growers discontinuing the use of azinphos-methyl and using other chemical controls for codling moth control (i.e., pyrethroids pyrethroids, diazinon). The alternatives to azinphos-methyl are not as effective and could potentially lead to pear fruit yield and quality impacts due to increased pest presence and pest damage. Secondary pest outbreaks could also result from alternative chemical control (i.e., pyrethroids), resulting in potential yield and quality impacts as well. (Pyrethroid use effectively ends IPM due to their elimination of mite predators.) Resistance will also likely become a more widespread problem because growers will have to rely on fewer chemicals for insect control.

**Phosmet and Azinphos-methyl:**

*Grower Level Impacts*

With the phosmet REI greater than 7 days and azinphos-methyl REIs at or below 7 days for irrigation and 14 days for fire blight removal, growers would not continue to use phosmet, and significant grower impacts are expected due to the lack of adequate 3rd generation codling moth control. The impacts include yield losses of 5-7% and changes in the end use market from losses in fruit quality. As a result of these impacts, pear growers in the Pacific Northwest Region and California could face losses of as much as $1,238 per acre and $918 per acre, respectively. At a minimum, grower profits in the Pacific Northwest would drop nearly 90% from current profit levels ($200 per acre), to $23 per acre (the range of profits would be -$1,238 per acre to $23 per acre in the Pacific Northwest). At a minimum in California, grower profits would drop 30% from current profit levels ($700 per acre), to $487 per acre (the range of profits would be -$918 to $487). (See General Assumptions section, Scenario 1.)

With azinphos-methyl REIs greater than 7 days for irrigation and 14 days for fire blight removal, and the phosmet REI less than or equal to 7 days, growers would not continue to use azinphos-methyl, and significant grower impacts are expected due to increased costs of alternative chemical control of codling moth. In the Pacific Northwest Region, profits would range from $132 to $153 per acre - a decline of 24% to 34% from current per acre profit levels of $200 per acre. In California, profits would range from $632 to $653 per acre - a decline of 7% to 10% from current per acre profit levels of $700 per acre. (See General Assumptions section, Scenario 2.)

With azinphos-methyl REIs greater than 7 days for irrigation and 14 days for fire blight removal, and the phosmet REI greater than 7 days, growers would not continue to use either azinphos-methyl or phosmet, and significant grower impacts are expected due to the lack of adequate control of codling moth and grape mealybug, and due to secondary pest outbreaks (i.e., mites and pear psylla). Impacts include yield losses of 20-25%, changes in the end use market from losses in fruit quality, and increased costs of alternative chemical control of codling moth, grape mealybug, and secondary pests. As a result of these impacts, growers would not make positive per acre profits. In the Pacific Northwest Region, profits would range from -$951 to -$2,247 per acre - a decline of 5 to 12 times the current per acre profit levels of $200 per acre. In California, profits would range from -$406 to -$1,881 per acre - a decline of 1.5 to 4 times the current per acre profit levels of $700. (See General Assumptions section, Scenario 3.)

*Regional Level Impacts*

With the phosmet REI greater than 7 days and azinphos-methyl REIs at or below 7 days for irrigation and 14 days for fire blight removal, growers would not continue to use phosmet, and significant grower impacts are expected due to the lack of adequate 3rd generation codling moth control. In the Pacific Northwest Region, where an average of 42,200 pear acres are grown, profits would range from -$9 million to $6 million - a decline of 1/3 to 2 times the current regional profit levels of $8.5 million. In California, where an average of 19,300 pear acres are grown, profits would range from $7.5 million to $12.7 million - a decline of 6% to 44% from current regional profit levels of $13.5 million. (See General Assumptions section, Scenario 1.)

With azinphos-methyl REIs greater than 7 days for irrigation and 14 days for fire blight removal, and the phosmet REI less than or equal to 7 days, growers would not continue to use azinphos-methyl, and significant grower impacts are expected due to increased costs of alternative chemical control of codling moth. In the Pacific Northwest Region profits would range from $6.3 million to $7 million - a decline of 18% to 26% from current regional profit levels of $8.5 million. In California, profits

would range from $12.9 million to $13.1 million - a decline of 3% to 4% from current regional profit levels of $13.5 million. (See General Assumptions section, Scenario 2.)

With azinphos-methyl REIs greater than 7 days for irrigation and 14 days for fire blight removal, and the phosmet REI greater than 7 days, growers would not continue to use either azinphos-methyl or phosmet, and significant grower impacts are expected due to the lack of adequate control of codling moth and grape mealybug, and due to secondary pest outbreaks (i.e., mites and pear psylla). In the Pacific Northwest Region profits would range from -$28 million to -$68 million - a decline of 4 to 9 times the current regional profit level of $8.5 million. In California, profits would range from -$10 million to $3.5 million - a decline of 3/4 to 1 3/4 times the current regional profit level of $13.5 million. (See General Assumptions section, Scenario 3.)

*National Level Impacts*

With the phosmet REI greater than 7 days and azinphos-methyl REIs at or below 7 days for irrigation and 14 days for fire blight removal, growers would not continue to use phosmet, and significant grower impacts are expected due to the lack of adequate 3$^{rd}$ generation codling moth control. In the U.S. profits could range from -$1.5 million to $18.7 million - a decline of 15% to 100% from current national profit levels of $22 million. (See General Assumptions section, Scenario 1.)

With azinphos-methyl REIs greater than 7 days for irrigation and 14 days for fire blight removal, and the phosmet REI less than or equal to 7 days, growers would not continue to use azinphos-methyl, and significant grower impacts are expected due to increased costs of alternative chemical control of codling moth. In the U.S. profits could range from $19.2 million to $20.1 million - a decline of 9% to 13% from current national profit levels. (See General Assumptions section, Scenario 2.)

With azinphos-methyl REIs greater than 7 days for irrigation and 14 days for fire blight removal, and the phosmet REI greater than 7 days, growers would not continue to use either azinphos-methyl or phosmet, and significant grower impacts are expected due to the lack of adequate control of codling moth and grape mealybug, and due to secondary pest outbreaks (i.e., mites and pear psylla). In the U.S. profits could range from -$24.5 million to -$78 million - a decline of 2 to 4 ½ times the current national profit level of $22 million . (See General Assumptions section, Scenario 3.)

**LIMITATIONS OF THE ANALYSIS**

Given the time and resource constraints, the benefits assessment is covering only the short-run impacts to pear growers net revenues (profits). The analysis is not attempting to measure the potential downstream impacts beyond the grower level of extending the azinphos-methyl and phosmet restricted entry intervals (REIs) to reduce post application worker exposure. Elements not included in this analysis include changes in cost for distributors, processors, and prices for consumers; impacts to market equilibrium; impacts to the U.S. pear export market; and changes in the channels of trade due to changes in costs of production, prices received at the farm gate level, or increases in foreign imports.

**GENERAL ASSUMPTIONS and INPUT VALUES**

**General Assumptions**

The following is a description of the assumptions made to calculate the impacts on pear grower revenues (yield and price), costs, and net revenues (profits) of extending the restricted entry intervals (REIs) for phosmet and azinphos-methyl on pears, and of the estimates of pear grower revenues, costs, and net revenues as a result of extending the REIs for phosmet and azinphos-methyl on pears.

Impacts are estimated for three scenarios as defined below. Each scenario represents a different combination of phosmet and azinphos-methyl REIs, with the assumption made that for any REI longer than 7 days for phosmet, and longer than 7 days for irrigation, and 14 days for fire blight removal for azinphos-methyl, pear growers will suffer impacts to their revenues received and/or costs of production. Impacts are measured in terms of the effect of changing azinphos-methyl and phosmet REIs (as set out in each scenario) on per acre grower revenues, costs, and net revenues. The grower level estimates of net revenues are aggregated up to a regional and national level, taking into account pear acres grown and pear acres treated with azinphos-methyl and phosmet (depending on the scenario) in each region.

The estimated impacts to yield, price, and cost were assumed based on the available information. The analysis is limited to changes in yield, price, and quality for the general categories of fresh and processed pears only. The estimates of current production, yield, and price are based on production and price data published in USDA's Noncitrus Fruits and Nuts 2000 Preliminary Summary. The estimates of current total, variable, and fixed costs are based on an enterprise budget for Oregon pear production.

Assumptions and estimated impacts are provided, by scenario and by region (i.e., Pacific Northwest and California), with separate sections for grower and regional level impacts. An estimate of national level impacts is provided as well. At the end of the assumptions section, are five tables summarizing the grower, regional, and national level impacts.

**SCENARIO 1**

Azinphos-methyl REI 14 days for fire blight removal and hand harvesting, and =/<7 days for all other activities; and phosmet REI > 7 days. Phosmet would no longer be used by growers.

**Pacific Northwest**

*Grower Level Impacts*

1. Assume if a grower is using azinphos-methyl or phosmet, they would treat every acre of pears on their farm with azinphos-methyl and phosmet.

2. Revenue Impact - f(yield, quality, price)

Revenues are impacted through changes in yield and in quality. Yield changes impact the quantity available for sale, and quality changes impact the price received for the quantity sold. The potential changes to yield and quality are as follows:

A. Assume for Pacific Northwest, produce 15 tons per acre, with value of approximately $4,000 per acre.

B. Assume an impact on yield - losses of 5-7% - due to lack of effective alternative control of codling moth prior to harvest. On a per acre level, a 5-7% yield loss equates to a reduction of yield of 0.75 to 1 ton per acre, reducing per acre yields to 14 - 14.25 tons per acre.

C. Assume a potential change in end use market of pear production as a result of an increased insect presence on fruit resulting in increased fruit damage (quality loss) with alternative chemical control for codling moth prior to harvest. This could potentially lead to a change in price for production.

Assume the distribution of fresh, processed, and fresh export pear production per acre is the same as on a national level - 42% of production domestic fresh, 40% of production domestic processed, and 18% of production fresh export. Also assume growers receive the same price for fresh export pears per ton as fresh domestic pears per ton. As a result, fresh production is equal to 60% of total per acre production. Therefore, if production 14 -14.25 tons per acre, fresh production is 8.5 tons per acre and processed production is 5.5-5.75 tons per acre.

Assume prices received by growers for fresh market pears equal to $326 per ton, and for processed market pears, $183 per ton. Also assume potential change in end use market only from fresh to processed - potential for change from fresh or processed to not sold is captured in the yield loss estimate. Therefore assume the potential change in price received for production equal to $0 per ton to $143 per ton.

D. If assume only yield loss, and no change in the end use market, and therefore price, per acre revenues would range from $3,777 (7% yield loss) to $3,823 (5% yield loss). If assume both yield loss and change in end use market, per acre revenues would range from $2,562 (7% yield loss and all for processed market) to $3,823 (5% yield loss, and no change in price).

Assume revenues would range from $2,562 to $3,823 per acre - a decline of 4% to 36% per acre (from $4,000 per acre).

3. Cost Impact

A. Assume costs could be as much as $3,800 per acre ($2,600 variable costs, and $1,200 fixed costs).

B. Assume fixed costs are unchanged.

C. Assume no change in variable costs due to additional insecticide control to replace the average of 2 applications of phosmet. Azinphos-methyl would be applied 4 times per season, as opposed to an average of two, to replace phosmet in-season control. Carbaryl would be applied late in the season to replace phosmet late-season control. The cost associated with these three applications (2 azinphos-methyl and 1 carbaryl) would not result in a increased in chemical control costs.

4. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre.

B. Assume revenues decline to $2,562 to $3,823 per acre, and costs are $3,800 per acre. The range of net revenues would equal -$1,238 to $23 per acre - a decline of nearly 1 to 7 times the current per acre profit.

C. Assume that total current farm profits equal $3,200 (an average of 16 acres per farm at profits of $200 per acre) in the Pacific Northwest Region from pear production.

D. Assume per farm profits decline to -$19,808 to $368 per farm - a decline of (again) nearly 1 to 7 times the current per farm profit - with the loss of phosmet for pear production in the Pacific Northwest Region.

*Regional Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre. Assume 42,200 pear acres grown in the Pacific Northwest Region. Assume net revenues of $8.5 million dollars in the Pacific Northwest Region from growing pears.

B. Assume revenues decline to $2,562 to $3,823 per acre, and costs $3,800 per acre. The range of net revenues would equal -$1,238 to $23 per acre.

Assume 29% of Pacific Northwest Region acreage treated with phosmet. Assume this is the acreage potentially impacted (12,238 acres). The remaining 29,962 acres will not be impacted.

Assume a range of profits of -$9 million to $6 million - a decline of 1/3 to 2 times current regional profit - in the Pacific Northwest Region producing pears without phosmet.

**California**

*Grower Level Impacts*

1. Assume if a grower is using azinphos-methyl or phosmet, they would treat every acre of pears on their farm with azinphos-methyl and phosmet.

2. Revenue Impact - f(yield, quality, price)

Revenues are impacted through changes in yield and in quality. Yield changes impact the quantity available for sale, and quality changes impact the price received for the quantity sold. The potential changes to yield and quality are as follows:

A. Assume for California, produce 17 tons per acre, with value of approximately $4,500 per acre.

B. Assume a major impact on yield - losses of 5-7% - due to lack of effective alternative control of codling moth prior to harvest. On a per acre level, a 5-7% yield loss equates to a reduction of yield of 1 to 1.25 tons per acre, dropping per acre yields to 15.75-16 tons per acre.

C. Assume a potential change in end use market of pear production as a result of an increased insect presence on fruit resulting in increased fruit damage (quality loss) with alternative chemical control. This could potentially lead to a change in price for production.

Assume the distribution of fresh, processed, and fresh export pear production per acre is the same as on a national level - 42% of production domestic fresh, 40% of production domestic processed, and 18% of production fresh export. Also assume growers receive the same price per ton for fresh export pears as for fresh domestic pears. As a result, fresh production equal to 60% of total per acre production. Therefore, if production is 15.75-16 tons per acre, fresh production is 9.5 tons per acre and processed production is 6.25-6.5 tons per acre.

Assume prices received by growers for fresh market pears equal to $326 per ton, and for processed market pears, $183 per ton. Also assume potential change in end use market only from fresh to processed - potential for change from fresh or processed to not sold is captured in the yield loss estimate. Therefore assume the potential change in price received for production equal to $0 per ton to $143 per ton.

D. If assume only yield loss, and no change in the end use market, and therefore no change in the price received, per acre revenues would range from $4,241 (7% yield loss) to $4,287 (5% yield loss). If assume both yield loss and change in end use market, per acre revenues would range from $2,882 (7% yield loss and all for processed market) to $4,287 (20% yield loss, and no change in price).

Assume revenues would range from $2,882 to $4,287 per acre - a decline of 5% to 36% per acre (from $4,500 per acre).

3. Cost Impact

A. Assume costs could be as much as $3,800 per acre ($2,600 variable costs, and $1,200 fixed costs).

B. Assume fixed costs are unchanged.

C. Assume no change in variable costs due to additional insecticide control to replace the average of 2 applications of phosmet. Azinphos-methyl would be applied 4 times per season, as opposed to an average of two, to replace phosmet in-season control. Carbaryl would be applied late in the season to replace phosmet late-season control. The cost associated with these three applications (2 azinphos-methyl and 1 carbaryl) would not result in a increased in chemical control costs.

4. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre.

B. Assume revenues decline to $2,882 to $4,287 per acre, and costs are $3,800 per acre. Net revenues would equal -$918 to $487 per acre - a decline of 1/3 to 2 1/3 times the current per acre profit level.

C. Assume that total current farm profits equal $12,600 (an average of 18 acres per farm at profits of $700 per acre) in California from the production of pears.

D. Assume per farm profits decline to -$16,524 to $8,766 - a decline of (again) 1/3 to 2 1/3 times the current per farm profit - due to the loss of phosmet for pear production in California.

*Regional Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre from pear production in California. Assume 19,300 pear acres grown in California. Assume net revenues of $13.5 million dollars in the California from growing pears.

B. Assume revenues decline to $2,882 to $4,287 per acre, and costs are $3,800. Net revenues would equal - $918 to $487 per acre.

Assume 19% of California acreage treated with phosmet. Assume this is the acreage potentially impacted (3,667 acres). The remaining 15,633 acres will not be impacted.

Assume profits of $7.5 million to $12.7 million - a decline of 6% to 44% - in California from growing pears without phosmet.

**Pacific Northwest and California**

*National Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre from pear production in the Pacific Northwest Region. Assume 42,200 pear acres grown in the Pacific Northwest Region. Assume net revenues of $8.5 million dollars in the Pacific Northwest Region from growing pears.

Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre from pear production in California. Assume 19,300 pear acres grown in California. Assume net revenues of $13.5 million dollars in California from growing pears.

Assume total revenues in the U.S. from growing pears is $22 million.

B. Assume that in the Pacific Northwest Region, without phosmet, revenues from pear production decline to $2,562 to $3,823 per acre, and costs are $3,800 per acre. Net revenues would equal -$1,238 to $23 per acre. Assume regional net revenues of -$9 million to $6 million.

Assume that in California, without phosmet, revenues decline to $2,882 to $4,287 per acre, and costs are $3,800. Net revenues would equal -$918 to $487 per acre. Assume regional profits of $7.5 million to $12.7 million in California from growing pears without phosmet.

Assume in the U.S., without phosmet, net revenues of -$1.5 million to $18.7 million - a decline of 15% to 100% from current profit levels.

**SCENARIO 2**

Azinphos-methyl REI >14 days for fire blight removal, and >7 days for all other activities; and phosmet REI/PHI less than or equal to 7 days. Azinphos-methyl would no longer be used by growers.

**Pacific Northwest**

*Grower Level Impacts*

1. Assume if a grower is using azinphos-methyl or phosmet, they would treat every acre of pears on their farm with azinphos-methyl and phosmet.

2. Revenue Impact - f(yield, quality, price)

Revenues are impacted through changes in yield and in quality. Yield changes impact the quantity available for sale, and quality changes impact the price received for the quantity sold. The potential changes to yield and quality are as follows:

A. Assume for Pacific Northwest, produce 15 tons per acre, with value of approximately $4,000 per acre.

B. Assume a no major impact on yield or quality. Growers still have phosmet for in- season and-late season control. However, over time, 2 to 3 years, could have resistance problems due to reliance on phosmet as primary control.

3. Cost Impact

A. Assume costs could be as much as $3,800 per acre ($2,600 variable costs, and $1,200 fixed costs).

B. Assume fixed costs are unchanged.

C. Assume a change in variable costs due to additional insecticide control to replace the average of 2 applications of azinphos-methyl.

1. Assume an additional 2-3 applications of phosmet (for a total of 4 to 5 applications) for the control of codling moth (with residual control of grape mealybug). Additional cost of $10 to $31 per acre.

2. Assume an additional 1 application of a pyrethroid (e.g., esfenvalerate), and 1 application of tebufenozide for resistance management. Additional cost of $37 per acre.

D. Variable cost increases for control of codling moth and grape mealy bug would range from $47 to $68 per acre.

E. Total costs would increase from $3,800 per acre to $3,847 to $3,868 per acre - an increase of 1% to 2%.

4. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre.

B. Assume revenues are $4,000 per acre, and costs increase to $3,847 to $3,868 per acre. Net revenues would equal $132 to $153 per acre- a decline of 24% to 34% from current per acre profit levels.

C. Assume that total current farm profits equal $3,200 (an average of 16 acres per farm at profits of $200 per acre) in the Pacific Northwest Region from pear production.

D. Assume per farm profits decline to $2,112 to $2,448 - a decline of (again) 24% to 34% per farm - with the loss of azinphos-methyl for pear production in the Pacific Northwest Region.

*Regional Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre. Assume 42,200 pear acres grown in the Pacific Northwest Region. Assume net revenues of $8.5 million dollars in the Pacific Northwest Region from growing pears.

B. Assume revenues are $4,000 per acre, and costs increase to $3,847 to $3,868 per acre. Net revenues would equal $132 to $153 per acre.

Assume 74% of Pacific Northwest Region acreage treated with azinphos-methyl. Assume this is the acreage potentially impacted (31,228 acres). The remaining 10,972 acres will not be impacted.

Assume regional profits of $6.3 million to $7 million - a decline of 18% to 26% from current regional profit levels- in the Pacific Northwest Region growing pears without azinphos-methyl.

**California**

*Grower Level Impacts*

1. Assume if a grower is using azinphos-methyl or phosmet, they would treat every acre of pears on their farm with azinphos-methyl and phosmet.

2. Revenue Impact - f(yield, quality, price)

Revenues are impacted through changes in yield and in quality. Yield changes impact the quantity available for sale, and quality changes impact the price received for the quantity sold. The potential changes to yield and quality are as follows:

A. Assume for California, produce 17 tons per acre, with value of approximately $4,500 per acre.

B. Assume a no major impact on yield or quality. Growers still have phosmet for in- season and late-season control. However, over time, 2 to 3 years, could have resistance problems due to reliance on phosmet as primary control.

3. Cost Impact

A. Assume costs could be as much as $3,800 per acre ($2,600 variable costs, and $1,200 fixed costs).

B. Assume fixed costs are unchanged.

C. Assume a change in variable costs due to additional insecticide control to replace the average of 2 applications of azinphos-methyl.

1. Assume an additional 2-3 applications of phosmet (for a total of 4 to 5 applications) for the control of codling moth (with residual control of grape mealybug). Additional cost of $10 to $31 per acre.

2. Assume an additional 1 application of a pyrethroid (e.g., esfenvalerate), and 1 application of tebufenozide for resistance management. Additional cost of $37 per acre.

D. Variable cost increases for control of codling moth and grape mealy bug would range from $47 to $68 per acre.

E. Total costs would increase from $3,800 per acre to $3,847 to $3,868 per acre - an increase of 1% to 2%.

4. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre.

B. Assume revenues are $4,500 per acre, and costs increase to $3,847 to $3,868 per acre. Net revenues would equal $632 to $653 per acre- a decline of 7% to 10% from current per acre profit levels.

C. Assume that total current farm profits equal $12,600 (an average of 16 acres per farm at profits of $700 per acre) in California from pear production.

D. Assume per farm profits decline to $11,376 to $11,754 - a decline of (again) 7% to 10% per farm - with the loss of azinphos-methyl for pear production in California.

*Regional Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre. Assume 19,300 pear acres grown in California. Assume net revenues of $13.5 million dollars in California from growing pears.

B. Assume revenues are $4,500 per acre, and costs increase to $3,847 to $3,868 per acre. Net revenues would equal $632 to $653 per acre.

Assume 47% of California acreage treated with azinphos-methyl. Assume this is the acreage potentially impacted (9,718 acres). The remaining 10,229 acres will not be impacted.

Assume regional profits of $12.9 million to $13.1 million - a decline of 3% to 4% from current regional profit levels - in California growing pears without azinphos-methyl.

**Pacific Northwest and California**

*National Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that in the Pacific Northwest, current revenues from the production of pears are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre. Assume 42,200 pear acres grown in the Pacific Northwest Region. Assume net revenues of $8.5 million dollars in the Pacific Northwest Region from growing pears.

Assume that in California, current revenues from the production of pears are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre. Assume 19,300 pear acres grown in the California. Assume net revenues of $13.5 million dollars in the Pacific Northwest Region from growing pears.

Assume total revenues in the U.S. from growing pears is $22 million.

B. Assume that in the Pacific Northwest Region, revenues are $4,000 per acre, and costs increase to $3,847 to $3,868 per acre. Net revenues would equal $132 to $153 per acre. Assume regional profits of $6.3 million to $7 million in the Pacific Northwest Region growing pears without azinphos-methyl.

Assume that in California, revenues are $4,500 per acre, and costs increase to $3,847 to $3,868 per acre. Net revenues would equal $632 to $653 per acre. Assume regional profits of $12.9 million to $13.1 million in California growing pears without azinphos-methyl.

Assume in the U.S., without azinphos-methyl in the production of pears, profits of $19.2 million to $20.1 million - a decline of 9% to 13% from current national profit levels.

**SCENARIO 3**

Azinphos-methyl REI >14 days for fire blight removal, and >7 days for all other activities; and phosmet REI > 7 days. Azinphos-methyl and phosmet would no longer be used by growers.

**Pacific Northwest**

*Grower Level Impacts*

1. Assume if a grower is using azinphos-methyl or phosmet, they would treat every acre of pears on their farm with azinphos-methyl and phosmet.

2. Revenue Impact - f(yield, quality, price)

Revenues are impacted through changes in yield and in quality. Yield changes impact the quantity available for sale, and quality changes impact the price received for the quantity sold. The potential changes to yield and quality are as follows:

A. Assume for Pacific Northwest, produce 15 tons per acre, with value of approximately $4,000 per acre.

B. Assume a major impact on yield - losses of 20-25% - due to lack of effective alternative control of codling moth. On a per acre level, a 20-25% yield loss equates to a reduction of yield of 3 to 4 tons per acre, dropping per acre yields to 11-12 tons per acre.

C. Assume a potential change in end use market of pear production as a result of an increased insect presence on fruit resulting in increased fruit damage (quality loss) with alternative chemical control. This could potentially lead to a change in price for production.

Assume the distribution of fresh, processed, and fresh export pears production per acre is the same as on a national level - 42% of production domestic fresh, 40% of production domestic processed, and 18% of production fresh export. Also assume growers receive the same price for fresh export pears per ton as fresh domestic pears per ton. As a result, fresh production equal to 60% of total per acre production. Therefore, if production 11-12 tons per acre, fresh production is 6.5-7 tons per acre and processed production is 4.5-5 tons per acre.

Assume prices received by growers for fresh market pears equal to $326 per ton, and for processed market pears, $183 per ton. Also assume potential change in end use market only from fresh to processed - potential for change from fresh or processed to not sold is captured in the yield loss estimate. Therefore assume the potential change in price received for production equal to $0 per ton to $143 per ton.

D. If assume only yield loss, and no change in the end use market, and therefore price, per acre revenues would range from $2,943 (25% yield loss) to $3,197 (20% yield loss). If assume both yield loss and change in end use market, per acre revenues would range from $2,013 (25% yield loss and all for processed market) to $3,197 (20% yield loss, and no change in price).

Assume revenues would range from $2,013 to $3,197 per acre - a decline of 30% to 56% per acre (from $4,600 per acre currently).

3. Cost Impact

A. Assume costs could be as much as $3,800 per acre ($2,600 variable costs, and $1,200 fixed costs).

B. Assume fixed costs are unchanged.

C. Assume a change in variable costs due to additional insecticide control to replace the average of 2 applications of phosmet and 2 applications of azinphos-methyl.

1. Alternative chemical controls for codling moth include pyrethroids (esfenvalerate, permethrin, fenpropathrin), carbaryl, tebufenozide, and diazinon. Additional codling moth control costs are as follows:

A. Pyrethroids: At least 2-3 additional applications, assume 2 each and 1-additional with esfenvalerate. Additional cost of $20/acre to $32/acre.

B. Carbaryl and diazinon: At least 1 carbaryl application just prior to harvest for last generation codling moth control, and 1 diazinon application during season. Additional cost of $18/acre.

C. Tebufenozide: At least 1 application of tebufenozide. Additional cost of $50/acre.

D. For mite control: At least 2-3 chemical applications for the control of mite outbreaks from the disruption of mite predators due to the use of pyrethroids. Abamectin used extensively for mites - additional cost of $160/acre to $240/acre for 2-3 applications.

E. For pear psylla control: At least 1 chemical application for the control of pear psylla outbreaks from the use of pyrethroids. Abamectin used extensively for pear psylla control - additional cost of $80 per acre for 1 application.

Cost increases due to changes in chemical control methods for codling moth could range from $328 per acre to $420 per acre.

2. For grape mealy bug control, assume chlorpyrifos would be used with 1-2 additional applications of imidacloprid. Additional cost of $20/acre to 40/acre.

D. Variable cost increases for control of codling moth and grape mealy bug would range from $348 to $460 per acre.

E. Total costs would increase from $3,800 per acre to $4,148 to $4,260 per acre - an increase of 9% to 12%.

4. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre.

B. Assume revenues decline to $2,013 to $3,197 per acre, and costs increase to $4,148 to $4,260 per acre. Net revenues would equal -$951 to -$2,247 per acre - a decline of 5 to 12 times the current per acre profit.

C. Assume that total current farm profits equal $3,200 (an average of 16 acres per farm at profits of $200 per acre) in the Pacific Northwest Region from pear production.

D. Assume per farm profits decline to -$15,216 to -$35,952 - a decline of (again) 5 to 12 times the current per farm profit - with the loss of azinphos-methyl and phosmet for pear production in the Pacific Northwest Region.

*Regional Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre. Assume 42,200 pear acres grown in the Pacific Northwest Region. Assume net revenues of $8.5 million dollars in the Pacific Northwest Region from growing pears.

B. Assume revenues decline to $2,013 to $3,197 per acre, and costs increase to $4,148 to $4,260 per acre. Net revenues would equal -$951 to -$2,247 per acre.

Assume 74% of Pacific Northwest Region acreage treated with phosmet and azinphos-methyl. Assume this is the acreage potentially impacted (31,228 acres). The remaining 10,972 acres will not be impacted.

Assume regional profits -$28 million to -$68 million - a decline of 4 to 9 times the current regional profits - in the Pacific Northwest Region growing pears without azinphos-methyl and phosmet.

**California**

*Grower Level Impacts*

1. Assume if a grower is using azinphos-methyl or phosmet, they would treat every acre of pears on their farm with azinphos-methyl and phosmet.

2. Revenue Impact - f(yield, quality, price)

Revenues are impacted through changes in yield and in quality. Yield changes impact the quantity available for sale, and quality changes impact the price received for the quantity sold. The potential changes to yield and quality are as follows:

A. Assume for California, produce 17 tons per acre, with value of approximately $4,500 per acre.

B. Assume a major impact on yield - losses of 20-25% - due to lack of effective alternative control of codling moth. On a per acre level, a 20-25% yield loss equates to a reduction of yield of 3 to 4 tons per acre, dropping per acre yields to 13-14 tons per acre.

C. Assume a potential change in end use market of pear production as a result of an increased insect presence on fruit resulting in increased fruit damage (quality loss) with alternative chemical control. This could potentially lead to a change in price for production.

Assume the distribution of fresh, processed, and fresh export pears production per acre is the same as on a national level - 42% of production domestic fresh, 40% of production domestic processed, and 18% of production fresh export. Also assume growers receive the same price for fresh export pears per ton as fresh domestic pears per ton. As a result, fresh production equal to 60% of total per acre production. Therefore, if production 13-14 tons per acre, fresh production is 7.75-8.25 tons per acre and processed production is 5.25-5.75 tons per acre.

Assume prices received by growers for fresh market pears equal to $326 per ton, and for processed market pears, $183 per ton. Also assume potential change in end use market only from fresh to processed - potential for change from fresh or processed to not sold is captured in the yield loss estimate. Therefore assume the potential change in price received for production equal to $0 per ton to $143 per ton.

D. If assume only yield loss, and no change in the end use market, and therefore no change in the price received, per acre revenues would range from $3,487 (25% yield loss) to $3,742 (20% yield loss). If assume both yield loss and change in end use market, per acre revenues would range from $2,379 (25% yield loss and all for processed market) to $3,742 (20% yield loss, and no change in price).

Assume revenues would range from $2,379 to $3,742 per acre - a decline of 17% to 47% per acre (from $4,500 per acre).

3. Cost Impact

A. Assume costs could be as much as $3,800 per acre ($2,600 variable costs, and $1,200 fixed costs).

B. Assume fixed costs are unchanged.

C. Assume a change in variable costs due to additional insecticide control to replace the average of 2 applications of phosmet and 2 applications of azinphos-methyl.

1. Alternative chemical controls for codling moth include pyrethroids (esfenvalerate, permethrin, fenpropathrin), carbaryl, tebufenozide, and diazinon. Additional codling moth control costs are as follows:

A. Pyrethroids: At least 2-3 additional applications, assume 2 each and 1-additional with esfenvalerate. Additional cost of $20/acre to $32/acre.

B. Carbaryl and diazinon: At least 1 carbaryl application just prior to harvest for last generation codling moth control, and 1 diazinon application during season. Additional cost of $18/acre.

C. Tebufenozide: At least 1 applications of tebufenozide. Additional cost of $50/acre.

D. For mite control: At least 2-3 chemical applications for the control of mite outbreaks from the disruption of mite predators due to the use of pyrethroids. Abamectin used extensively for mites - additional cost of $160/acre to $240/acre for 2-3 applications.

E. For pear psylla control: At least 1 chemical application for the control of pear psylla outbreaks from the use of pyrethroids. Abamectin used extensively for pear psylla control - additional cost of $80 per acre for 1 application.

Cost increases due to changes in chemical control methods for codling moth could range from $328 per acre to $420 per acre.

2. For grape mealy bug control, assume chlorpyrifos would be used with 1-2 additional applications of imidacloprid. Additional cost of $20/acre to 40/acre.

D. Variable cost increases for control of codling moth and grape mealy bug would range from $348 to $460 per acre.

E. Total costs would increase from $3,800 per acre to $4,148 to $4,260 per acre - an increase of 9% to 12%.

4. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre.

B. Assume revenues decline to $2,379 to $3,742 per acre, and costs increase to $4,148 to $4,260 per acre. Net revenues would equal -$406 to -$1,881 per acre - a decline of 1 to 4 times current per acre profits.

C. Assume that total current farm profits equal $12,600 (an average of 18 acres per farm at profits of $700 per acre) in California from the production of pears.

D. Assume per farm profits decline to -$7,308 to -$33,858 - a decline of (again) 1 to 4 times current per farm profits - due to the loss of azinphos-methyl and phosmet for pear production in California.

*Regional Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre from pear production in California. Assume 19,300 pear acres grown in California. Assume net revenues of $13.5 million dollars in the California from growing pears.

B. Assume revenues decline to $2,379 to $3,742 per acre, and costs increase to $4,148 to $4,260 per acre. Net revenues would equal -$406 to -$1,881 per acre.

Assume 47% of California acreage treated with phosmet and azinphos-methyl. Assume this is the acreage potentially impacted (9,071 acres). The remaining 10,229 acres will not be impacted.

Assume regional profits of -$10 million to $3.5 million - a decline of 3/4 to 1 3/4 times current regional profits - in California from growing pears without azinphos-methyl and phosmet.

**Pacific Northwest and California**

*National Level Impacts*

1. Net Revenue (Profit) Impacts

A. Assume in the Pacific Northwest Region that current revenues are equal to $4,000 per acre, and costs are $3,800 per acre, resulting in net revenues of $200 per acre. Assume 42,200 pear acres grown in the Pacific Northwest Region. Assume net revenues of $8.5 million dollars in the Pacific Northwest Region from growing pears.

Assume that current revenues are equal to $4,500 per acre, and costs are $3,800 per acre, resulting in net revenues of $700 per acre from pear production in California. Assume 19,300 pear acres grown in California. Assume net revenues of $13.5 million dollars in California from growing pears.

Assume total revenues in the U.S. from growing pears is $22 million.

B. Assume that in the Pacific Northwest Region, revenues decline to $2,013 to $3,197 per acre, and costs increase to $4,148 to $4,260 per acre without azinphos-methyl and phosmet for pear production. Net revenues would equal -$951 to -$2,247 per acre. Assume regional profits of -$28 million to -$68 million.

Assume that in California, revenues decline to $2,379 to $3,742 per acre, and costs increase to $4,148 to $4,260 per acre without azinphos-methyl and phosmet for pear production. Net revenues would equal -$406 to -$1,881 per acre. Assume regional profits of -$10 million to $3.5 million.

Assume in the U.S., without azinphos-methyl and phosmet in the production of pears, profits of -$24.5 million to -$78 million - a decline of 2 to 4.5 times the current national profit level.

**Summary of Impacts**

The following four tables summarize, by scenario, the grower, regional, and national impacts of extending the REIs of azinphos-methyl and phosmet on pears. Tables 1 and 2 summarize grower level impacts in the Pacific Northwest Region and California, respectively. Table 3 summarizes regional level impacts in the Pacific Northwest Region and California. Table 4 summarizes national level impacts.

Table 1. Summary of Pacific Northwest Region Grower Level Impacts

| Scenario | Yield | Quality Impact (Price) | Revenues | Costs | Net Revenues |
|---|---|---|---|---|---|
| Current Situation | Current total: 15 tons/A | Prices: Fr: $326/ton Proc: $183/ton | Current: $4,000/A | Current: $3,800/A | Current: $200/A |
| 1 REIs: Azinphos-methyl: 14 days, 7 days Phosmet: > 7 days | Yield loss: 5-7% Reduces Yield to: Total: 14 - 14.25 tons/A Fr: 8.5 tons/A Proc: 5.5 - 5.75 tons/A | Quality Change: Fr: 0 - 8.5 tons/A Proc: 5.5 - 14.25 tons/A | New: $2,562/A to $3.823/A | No change | New: -$1,238/A to $23/A **Net Loss:** $177/A to $1,438/A |
| 2 REIs: Azinphos-methyl: >14 days, >7 days Phosmet: =/<7 days | Yield loss: None | No Quality Change | No change | New: $3,847/A to $3,868/A | New: $132/A to $153/A **Net Loss:** $47/A to $68/A |
| 3 REIs: Azinphos-methyl: >14 days, >7 days Phosmet: > 7 days | Yield loss: 20-25% Reduces Yield to: Total: 11-12 tons/A Fr: 6.5-7 tons/A Proc: 4.5-5 tons/A | Quality Change: Fr: 0 - 7 tons/A Proc: 4.5 - 12 tons/A | New: $2,013/A to $3,197/A | New: $4,148/A to $4,260/A | New: -$951/A to -$2,247/A **Net Loss:** $1,151/A to $2,447/A |

Table 2. Summary of California Grower Level Impacts

| Scenario | Yield | Quality Impact (Price) | Revenues | Costs | Net Revenues |
|---|---|---|---|---|---|
| Current Situation | Current total: 17 tons/A | Prices: Fr: $326/ton Proc: $183/ton | Current: $4,500/A | Current: $3,800/A | Current: $700/A |
| 1 REIs: Azinphos-methyl: 14 days, 7 days Phosmet: > 7 days | Yield loss: 5-7% Reduces Yield to: Total: 15.75 - 16 tons/A Fr: 9.5 tons/A Proc: 6.25 - 6.5 tons/A | Quality Change: Fr: 0 - 9.5 tons/A Proc: 6.25 - 16 tons/A | New: $2,882/A to $4,287/A | No change | New: -$918/A to $487/A **Net Loss:** $213/A to $1,618/A |
| 2 REIs: Azinphos-methyl: >14 days, > 7 days Phosmet: =/<7 days | Yield loss: None | No Quality Change | No change | New: $3,847/A to $3,868/A | New: $632/A to $653/A **Net Loss:** $47/A to $68/A |
| 3 REIs: Azinphos-methyl: >14 days, >7 days Phosmet: > 7 days | Yield loss: 20-25% Reduces Yield to: Total: 13-14 tons/A Fr: 7.75-8.25 tons/A Proc: 5.25-5.75 tons/A | Quality Change: Fr: 0 - 8.25 tons/A Proc: 5.25 - 14 tons/A | New: $2,379/A to $3,742/A | New: $4,148/A to $4,260/A | New: -$406/A to -$1,881/A **Net Loss:** $1,108/A to $2,581/A |

Table 3. Summary of Regional Level Impacts

| Scenario | Region | Net Revenues |
|---|---|---|
| 1<br>REIs:<br>Azinphos-methyl: 14 days, 7 days<br><br>Phosmet: > 7 days | Pacific Northwest | Current total: $8.5 million<br>New Total: -$9 million to $6 million<br>**Net Loss:** $2.5 million to $17.5 million |
| | California | Current total: $13.5 million<br>New Total: $7.5 million to $12.7 million<br>**Net Loss:**$0.8 million to $6 million |
| 2<br>REIs:<br>Azinphos-methyl: > 14 days, >7 days<br><br>Phosmet: =/<7 days | Pacific Northwest | Current total: $8.5 million<br>New Total: $6.3 million to $7 million<br>**Net Loss:**$1.5 million to $2.2 million |
| | California | Current: $13.5 million<br>New Total: $12.9 million to $13.1 million<br>**Net Loss:** $0.4 million to $0.6 million |
| 3<br>REIs:<br>Azinphos-methyl: >14 days,<br>> 7 days<br>Phosmet: > 7 days | Pacific Northwest | Current total: $8.5 million<br>New Total: -$28 million to -$68 million<br>**Net Loss:** $36.5 million to $76.5 million |
| | California | Current total: $13.5 million<br>New Total: -$10 million to $3.5 million<br>**Net Loss:** $10 million to $23.5 million |

Table 4. Summary of National Level Impacts

| Scenario | Region | Net Revenues |
|---|---|---|
| 1<br>REIs:<br>Azinphos-methyl: 14 days, 7 days<br>Phosmet: > 7 days | U.S. | Current total: $22 million<br>New Total: -$1.5 million to $18.7 million<br>**Net Loss:** $3.3 million to $23.5 million |
| 2<br>REIs:<br>Azinphos-methyl: >14 days, >7 days<br>Phosmet: =/<7 days | U.S. | Current total: $22 million<br>New Total: $19.2 million to $20.1 million<br>**Net Loss:** $1.9 million to $2.8 million |
| 3<br>REIs:<br>Azinphos-methyl: >14 days, >7 days<br>Phosmet: > 7 days | U.S. | Current total: $22 million<br>New Total: -$24.5 million to -$78 million<br>**Net Loss:** $73.5 million to $127 million |

**Input Values**

1. Yield/acre, average acres per farm, value per farm, and value per acre are as follows by state and region.

| Region/State | Number of Farms | Bearing Acres per Farm (avg.) | Yield (avg. tons per acre) | Value of Production ($1000) | Value of Prod. per Farm ($) (avg.) |
|---|---|---|---|---|---|
| California | 1,047 | 18 | 17 | $77,364 | $74,000 |
| Pacific North | 2,701 | 16 | 15 | $203,249 | $75,250 |
| Oregon | 983 | 18 | 14 | $88,704 | $90,250 |
| Washington | 1,718 | 14 | 17 | $114,545 | $66,700 |
| U.S. | 8,062 | 8 | 15 | $289,810 | $36,000 |

Sources: USDA 1997 Agricultural Census; USDA 2000 Agricultural Statistics.

2. Application cost of active ingredients used on U.S. pears.

| Chemical | Average Cost of Chemical ($/acre/application) |
|---|---|
| Azinphos-methyl | $16 |
| Carbaryl | $8 |
| Chlorpyrifos | $21 |
| Diazinon | $10 |
| Esfenvalerate | $12 |
| Fenpropathrin | $15 |
| Imidacloprid | $44 |
| Phosmet | $21 |
| Permethrin | $20 |
| Tebufenozide | $25 |

Source: EPA proprietary usage data.

3. U.S. 2000 Pear Production and Prices by End Use Market

| End use Market | Production (tons) | Price (average $/ton) |
|---|---|---|
| Total Production | 957,200 | $267 |
| Domestic Fresh | 399,109 | $326 |
| Domestic Processed | 392,450 | $183 |
| Export Fresh | 165,641 | $326 |

Sources: USDA Noncitrus Fruits and Nuts 2000 Preliminary Summary, and USDA Foreign Agricultural Trade of the United States (FATUS).

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